Oct. 7, 1969 H. H. TIEDEMANN 3,471,383

CONTINUOUS ANODE FOR ELECTROLYTIC CELLS

Filed Feb. 5, 1965

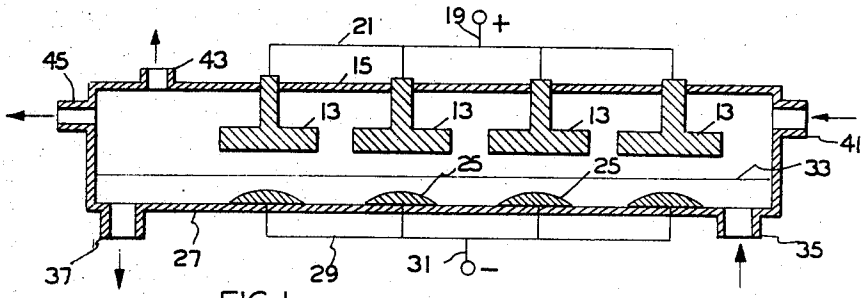


FIG. 1

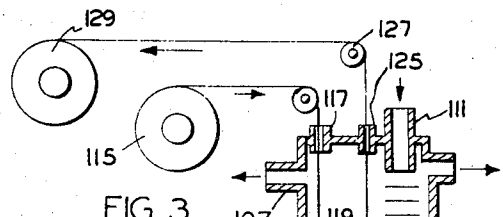


FIG. 3

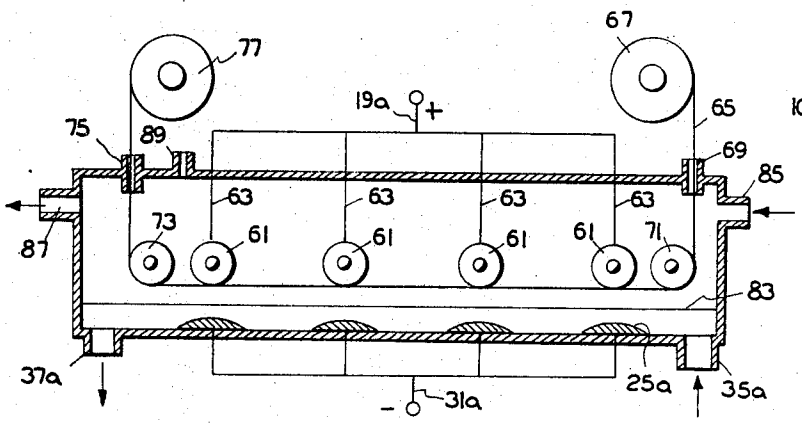


FIG. 2

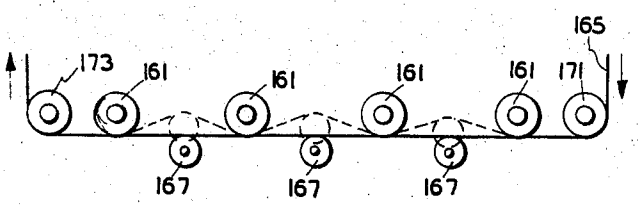
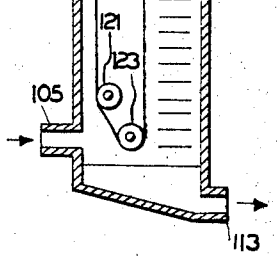


FIG. 4



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3,471,383

Patented Oct. 7, 1969

3,471,383

CONTINUOUS ANODE FOR ELECTROLYTIC CELLS

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Filed Feb. 5, 1965, Ser. No. 430,684
Int. Cl. C22d *1/04;* C01d *1/08;* B01k *3/08*
U.S. Cl. 204—99 9 Claims

ABSTRACT OF THE DISCLOSURE

A movable web impregnated with carbon is substituted for a consumable carbon anode in an electrolytic cell.

The present invention relates to an improved continuous anode for electrolytic cells. It involves use of elongated flexible web material which is particularly suitable for use as anodic material in electrolytic chlorine caustic cells, but it has uses also in other types of electrolytic cells.

In the prior art, chlorine and caustic soda have generally been produced by electrolysis of sodium chloride, using massive stationary graphite anodes and cathodes of mercury and the like. A typical unit, for example, contains 42 cells, each provided with 144 stationary graphite anodes which weigh about 65 pounds each. Such a plant has a rated capacity of something like 180 tons of chlorine per day. As these cells are used, the graphite blocks or anodes gradually are consumed due to chemical oxidation. They diminish in thickness as oxidation, especially chlorination, takes place. It is estimated that about six pounds of graphite anodes are used up for every ton of chlorine produced. Graphite as such is not necessarily or particularly expensive but the steps necessary for its replacement frequently may be.

Ultimately, the conventional graphite anodes described above are consumed to the point where they become very thin. Their electrical resistance rises and they also become deficient in mechanical strength. Hence, they must be replaced. Replacement with new anodes is an expensive procedure, not so much due to the cost of the anode per se but more particularly because the cell which is affected must be taken out of production while the anode is replaced. Replacement also entails considerable labor. In conventional practice, the cell covers are removed after the system has been shut down. Then a rather tedious operation of removing the spent anode blocks and replacing them with fresh anode blocks is undertaken. Thereafter the cell must be reassembled and put back into operation. In a typical operation, it requires about four days to replace the carbonaceous or graphitic anodes in a cell, in some cases, more. During this time, the cell is producing nothing. A number of men, as many as five, are commonly employed in a large plant continuously for the sole purpose of replacing spent anodes in electrolytic cells.

A particular object of the present invention is to make it possible to eliminate the conventional anode block replacement described above.

It is obvious that efficient operation of an electrolytic cell greatly affects the economics of a plant for producing chlorine and caustic soda. The same applies to other plants of comparable design and purpose. In such plants, a typical cell normally operates with an applied electrical potential in the range of about 4 to 5 volts. As the stationary graphite blocks mentioned above are gradually depleted, the voltage in the cell rises. The resistance of each block increases and, ordinarily, in an effort to reduce the voltage drop, the blocks may be gradually lowered

further into the cell, i.e., closer to the mercury layer. There is a practical limit to such. But any unnecessary voltage drop is very costly. In a typical plant each $\frac{1}{10}$ of a volt per cell required for operating the entire plant represents an annual cost of $40,000 for electricity.

In addition to the cost of electric power, in conventional practice, two full-time employees are required to adjust more or less continuously the height of the anodes in an effort to control the voltage drop as the anodes are depleted. Besides eliminating this labor, the use of a continuous anode, as is taught by the present invention, permits continuous operation of the unit with a steady voltage or with a minimum voltage drop.

The present invention involves as a particular feature the use of a graphite cloth web as an anode. This web is a long strip of fabric well loaded with the carbonaceous material. In addition to the web, of course, contactors are provided in the apparatus for the efficient distribution of electric current through the graphite web or cloth. The arrangement is such that the wear or attrition of the carbonaceous substance of the graphite or graphite-loaded cloth is quite uniform. The cloth or web is moved by suitable simple mechanism, and preferably continuously, or at regular short intervals, so as to take care of the depletion of the graphite substance and keep the cell opearting in a uniform manner. With the present arrangement, depletion is very slow, preferably a new graphite loaded cloth is fed in at one end of the cell and passed through the cell at such a rate that its useful life or carbon content for electrolytic purposes is fairly well spent by the time it emerges from the cell. By suitable arrangement of electric contacts, full use is obtained from the cloth and most of the difficulties described above are completely avoided.

The arrangement of the present invention preferably is such that a long web of cloth or fabric anode either fabricated largely of graphite, or impregnated with graphite to a suitable degree, is fed into the cell at one end and out the other end at such a rate that it is substantially completely consumed. In some cases the web may be fed through the cell and back near the point of entrance before it leaves the cell. The arrangement preferably is such that the voltage rise to compensate for changes in conductivity is minimal. The invention contemplates that the spent carbon bearing web or anode preferably be continuously reeled out of the cell for discard, although as noted above the movement may be discontinuous provided it is made at frequent intervals.

According to the present invention, the continuous anode web may be passed through either a horizontal cell or a vertical cell, both types being well known. In general, the same principles are involved in both situations.

The invention will be more fully understood by referring to the drawings which form a part of this specification.

In said drawings, FIGURE 1 is a diagrammatic view of a typical prior art cell in vertical section showing the conventional graphite anodes in the form of blocks suspended into the cell.

FIGURE 2 shows the concept of the present invention as applied to a continuous flexible web anode in a horizontal cell. This view is generally like that of FIGURE 1, the same basic cell arrangement being involved but the stationary block anodes are replaced with a continuous flexible web of suitable conductive carbon bearing or graphitic cloth.

FIGURE 3 shows a vertical type cell in which the principles of the invention are involved, this being a vertical sectional view.

FIGURE 4 illustrates a variation in the system of FIGURE 2.

Referring in greater detail to the drawings, FIGURE 1 shows a basic layout for a typical mercury type chlorine-caustic cell. Anodes **13**, of which four are shown, are suspended from the ceiling of the cell in such a manner that they can be lowered, i.e., their height may be adjusted. Suspending means are not shown except that each block has an upwardly extending column passing through the ceiling **15** of the cell. Electric current is supplied from a source **19**, distributed through several conductors **21** to the several anodes. Cathode contactor points or members **25** are shown resting on the floor **27** of the cell, these being electrically connected through suitable conductors **29** to the negative side of the current supply **31**.

The cathodic points **25**, which are in multiple and preferably in about the same number as the anode blocks **11**, supply current to the cathodic layer **33** of mercury. The latter flows through an inlet **35** into the cell and moves to the left along the floor of the cell in a horizontal layer **33** to outlet **37**. From the latter, the mercury which by now is an amalgam with sodium is taken to the denuder for mercury recovery. The recovered mercury is then recycled through inlet **35**. The same system obviously is applicable to treatment of other salts, especially other alkali metal halides besides sodium chloride.

The strong brine of the salt being electrolyzed is supplied through inlet line **41**, shown at the right of the cell. It flows along the cell from right to left as electrolysis takes place. Gaseous chlorine is evolved from the top of the cell through outlet **43** and the spent brine passes out through outlet **45**. The sodium of course is converted primarily to NaOH.

As pointed out above, the conventional graphite anodes **11** are rapidly consumed. In a commercial cell, the number of anodes may vary considerably. Four only are shown in FIGURE 1, but in a commercial cell the number usually is much greater.

By comparison, the arrangement of the present invention for a horizontal cell is shown in FIGURE 2. Here the body of the cell is much the same as that of FIGURE 1, mercury being supplied through inlet **35***a* and the mercury-sodium amalgam passing out through outlet **37***a*. Electric current is supplied from the positive source **19***a* and negative source **31***a*. Anode points **25***a* are the same as in FIGURE 1 in general arrangement.

Instead of supplying current from the positive leads to graphitic anodes as in FIGURE 1, in this case these leads are attached to conductive roller members **61** through leads **63**. These rollers contact the conductive carbonaceous or graphite-loaded fabric **65**, which is a key element in the present invention. This web is fed from a supply roll **67** through an opening **69** in the top of the cell and thence around a guide roller **71** and underneath the contact rollers **61** to a second guide roller **73**. The rate of movement of the web, by drive means of conventional type not shown, is adjusted so that the carbon or graphite is just about fully consumed as the web emerges from the bath. As the web passes around roller **73** the graphite in the web has been quite fully consumed. The spent web then passes upwardly from guide roller **73** through an outlet opening **75** in the top of the cell. Outlet **75** is designed to prevent substantial chlorine gas leakage. It is rewound on take-up roller **77**. It may be discarded or in many cases it can be impregnated with carbon for reuse.

The mercury layer **83** in FIGURE 2 is essentially the same as layer **33** in FIGURE 1. In both cases the anodes must be kept above and out of contact with the mercury layer.

As in the case of FIGURE 1, fresh brine flows in through inlet **85** on the right and the spent brine emerges through outlet **87** at the left. Chlorine gas passes out through the outlet **89** to a suitable tank or storage system.

Referring next to FIGURE 3, there is shown a vertical type cell having walls **101** and **103** which enclose the brine being electrolyzed. The strong brine enters through inlet **105** and the weak spent brine emerges through outlet **107**. In this case a continuous mercury film, which serves as the cathode, is obtained by spilling the denuded mercury entering at the top through inlet **111** down over a vertical cathodic grid. The latter is indicated diagrammatically at **113**. In its passage down the grid, the mercury is converted to the sodium amalgam. At the bottom of the cell, the amalgam is pumped off through outlet **113** to the denuder system which is conventional and forms no part of the present invention. The continuous anodic web of graphite cloth is supplied from a reel **115**. It enters at the top of the cell through an inlet **117**. This inlet is narrow enough to prevent any substantial loss of chloride gas. The web **119** passes downwardly around a pair of guide rollers **121** and **123**. From the latter the web passes upwardly through the vessel and thence through outlet **125** and around guide roller **127** to a take-up reel **129**. The spent web is rewound on the latter and can be discarded or subsequently carbonized or graphited anew to serve as a new anode.

In some respects the mechanical features involved in reeling the cloth through the vertical cell are simpler than those in the horizontal cell. There is no long horizontal run to support out of contact with a mercury layer. Current is supplied to the web through suitable electric contactors such as the rollers **127** and **121** and **123**. The connections are not shown but would be obvious to those skilled in the art. In addition, supplemental contact rollers may be positioned along the path of the graphite web, along the incoming downward traveling stretch if desired and particularly along the rising stretch. Sufficiently conductive contacts must be supplied to give effective electrolytic current to the cell. These are omitted from FIGURE 3 in the interest of simplicity, their nature and number being dependent obviously on the capacity of the cell and its size, as will be apparent to those skilled in the art.

Normally, in the arrangement of FIGURE 2, the web will be buoyed up against the contacting rollers **61** sufficiently that no additional support means are required. Under some circumstances, however, and depending on the length of the web, the tension applied thereto and the spacing of the contact roller **61**, additional support may be needed. An arrangement for this purpose is shown in FIGURE 4.

In FIGURE 4 it will be understood that the web **165** is essentially the same as web **65** in FIGURE 2, and its arrangement and functioning are similar. The only difference is that additional support rollers **167** are provided in the bath. These must be kept above the mercury level to avoid shorting out the cell, and therefore they are preferably small rollers. Moreover, they may be raised or lowered, as indicated in the dotted lines, to cause the web to make better electrical contact, that is, to wrap more effectively around the guide rollers **161**, which correspond in other respects to roller **61** of FIGURE 2. This arrangement affords better electrical contact between the web and the main guide rollers. If desired, the rollers **167** may be raised until their lower surfaces are essentially in line with the lower surfaces of guide rollers **161**, as well as rollers **171** and **173**. The latter correspond to the rollers **71** and **73** of FIGURE 2. This arrangement may be desirable or necessary in some cases to avoid shorting the cell by the rollers being too close to the mercury layer.

Graphite cloth is a relatively new product and is preferred for the purposes of the present invention. It is possible, however, to use other carbonaceous webs or carbon-loaded webs of various fabrics for accomplishing the same general purposes. The web material must be one which will not distintegrate in the bath. It will be appreciated that the present invention eliminates many problems connected with the prior art practices.

It will be understood that various mechanical arrangements and modifications other than those shown and described above may be made, as will be obvious to those skilled in the art. Essentially, the system requires maintenance of good electrical contact with the fabric web.

It requires that the web itself have a good content of conductive graphite. It is also essential, of course, that it be kept out of contact with the mercury layer, but properly spaced therefrom so as to obtain maximum operating efficiency at optimum voltage and current values.

It is intended by the claims which follow to cover the variations and modifications in the system which would occur to those skilled in the art.

What is claimed is:

1. The method of operating an electrolytic cell having a mercury cathode for production of a halogen from a brine, said cell being provided with a traveling anode comprising an elongated web of graphite-loaded fabric comprising passing said anode into and through said brine at such a rate that said graphite is substantially completely consumed when said web emerges from the brine.

2. The method of claim 1 in which said elongated web contacts a plurality of conductive roller members which are connected to a source of positive electric current.

3. The method of claim 2 in which said graphite diminishes in proportion to distance that said web has moved through said brine when said rate of travel is constant.

4. The method of claim 3 in which the distance between the surfaces of said web and of said mercury cathode is varied to maintain maximum efficiency at optimum voltage and current values.

5. The method of claim 4 in which said mercury cathode is horizontally disposed along the bottom of said electrolytic cell and said web is maintained at a selected distance thereabove so that voltage rise, which compensates for changes in conductivity of said traveling anode with progressive consumption of graphite, is minimal.

6. The method of claim 2 in which said electrolytic cell is a vertical type cell.

7. The method of claim 6 in which said mercury cathode is a continuous mercury film which is obtained by spilling denuded mercury, entering at the top of said electrolytic cell, over a vertical cathodic grid.

8. The method of claim 4 in which said fabric of said elongated web is loaded again with graphite for re-use.

9. The method of claim 4 in which said web moves discontinuously in short increments of travel.

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U.S. Cl. X.R.

204—206, 219, 294